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Lee et al.

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(54) **METHOD AND SYSTEM FOR IMPLEMENTING ALARMS FOR MEDICAL DEVICE THROUGH MOBILE DEVICE**

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CPC ***G08B 21/02*** (2013.01); ***A61B 5/0002*** (2013.01); ***A61B 5/0022*** (2013.01); ***G06F 19/3418*** (2013.01); ***H04M 1/72538*** (2013.01)

(58) **Field of Classification Search**
CPC G06F 19/3418; H04M 1/72538; A61B 5/0002; A61B 5/0022
USPC 340/539.12; 705/2; 455/66.1, 411
See application file for complete search history.

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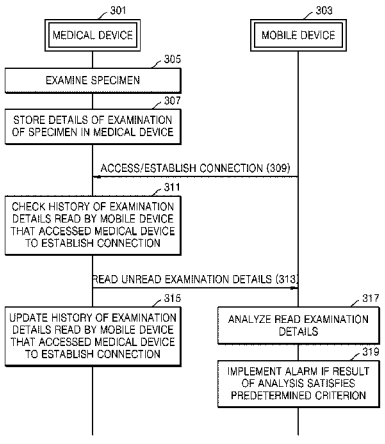
(74) *Attorney, Agent, or Firm* — Sughrue Mion, PLLC

(57) **ABSTRACT**

Provided are a method and system for implementing alarms for a medical device through a mobile device. The method includes: storing details of examination of a specimen (hereinafter, referred to as examination details) in the medical device, wherein the storing is performed by the medical device; accessing the medical device and establishing a connection with the medical device, wherein the accessing and the establishing of the connection is performed by the mobile device; reading the examination details stored in the medical device, wherein the reading is performed by the mobile device; analyzing the read examination details, wherein the analyzing is performed by the mobile device; and implementing an alarm if the result of analysis satisfies a predetermined criterion, wherein the implementing is performed by the mobile device.

32 Claims, 11 Drawing Sheets



(51) **Int. Cl.**

A61B 5/00	(2006.01)
H04M 1/725	(2006.01)
G06F 19/00	(2011.01)

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2010/0081895	A1	4/2010	Zand
2010/0094098	A1	4/2010	Smith et al.
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FIG. 1A (RELATED ART)

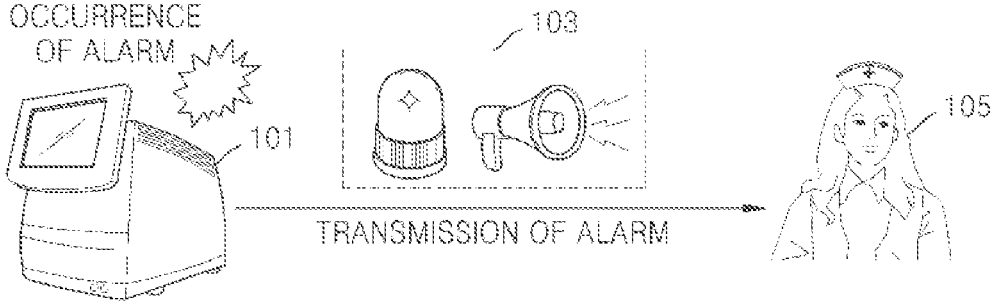


FIG. 1B (RELATED ART)

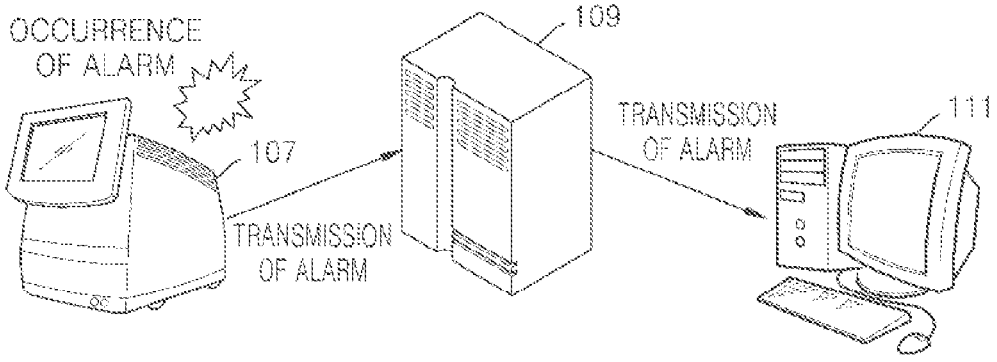


FIG. 2

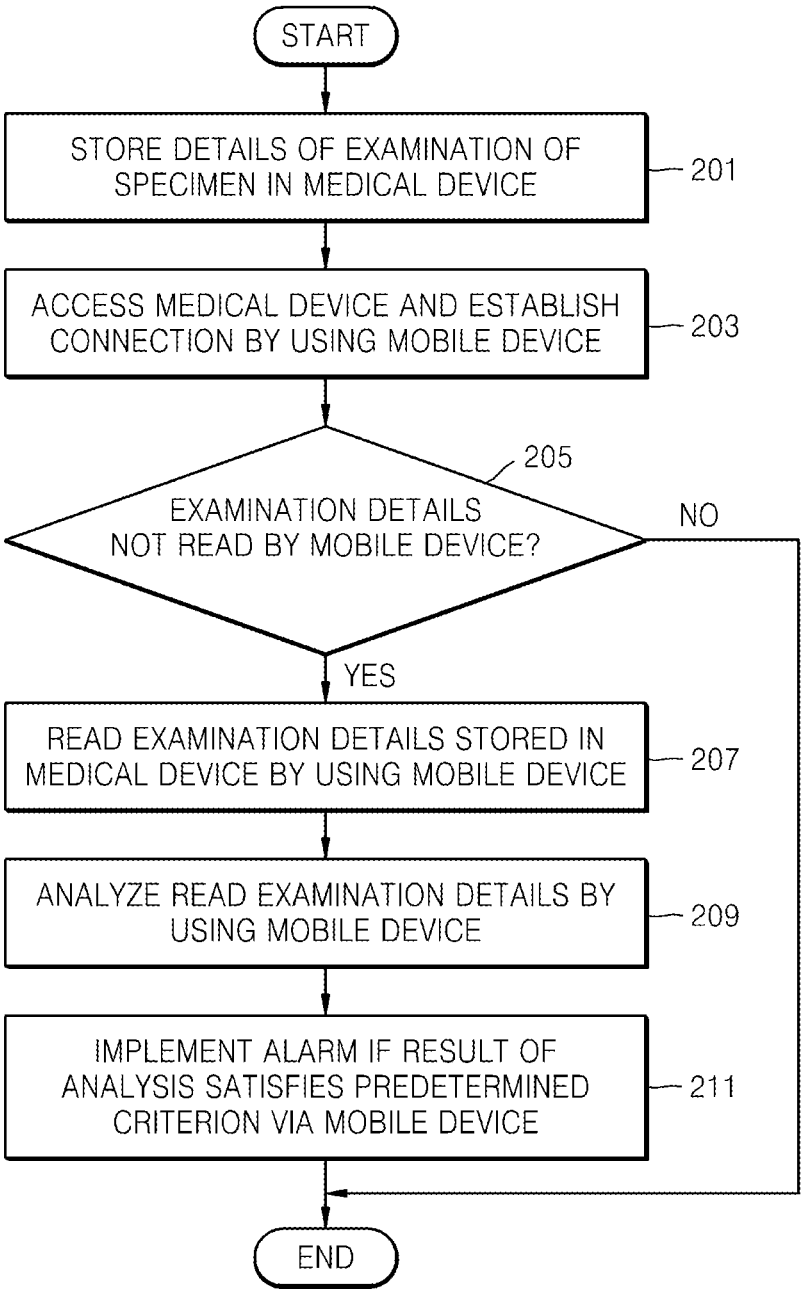

START
STORE DETAILS OF EXAMINATION OF SPECIMEN IN MEDICAL DEVICE
201
ACCESS MEDICAL DEVICE AND ESTABLISH CONNECTION BY USING MOBILE DEVICE
203
205
EXAMINATION DETAILS NOT READ BY MOBILE DEVICE?
NO
YES
READ EXAMINATION DETAILS STORED IN MEDICAL DEVICE BY USING MOBILE DEVICE
207
ANALYZE READ EXAMINATION DETAILS BY USING MOBILE DEVICE
209
IMPLEMENT ALARM IF RESULT OF ANALYSIS SATISFIES PREDETERMINED CRITERION VIA MOBILE DEVICE
211
END

FIG. 3

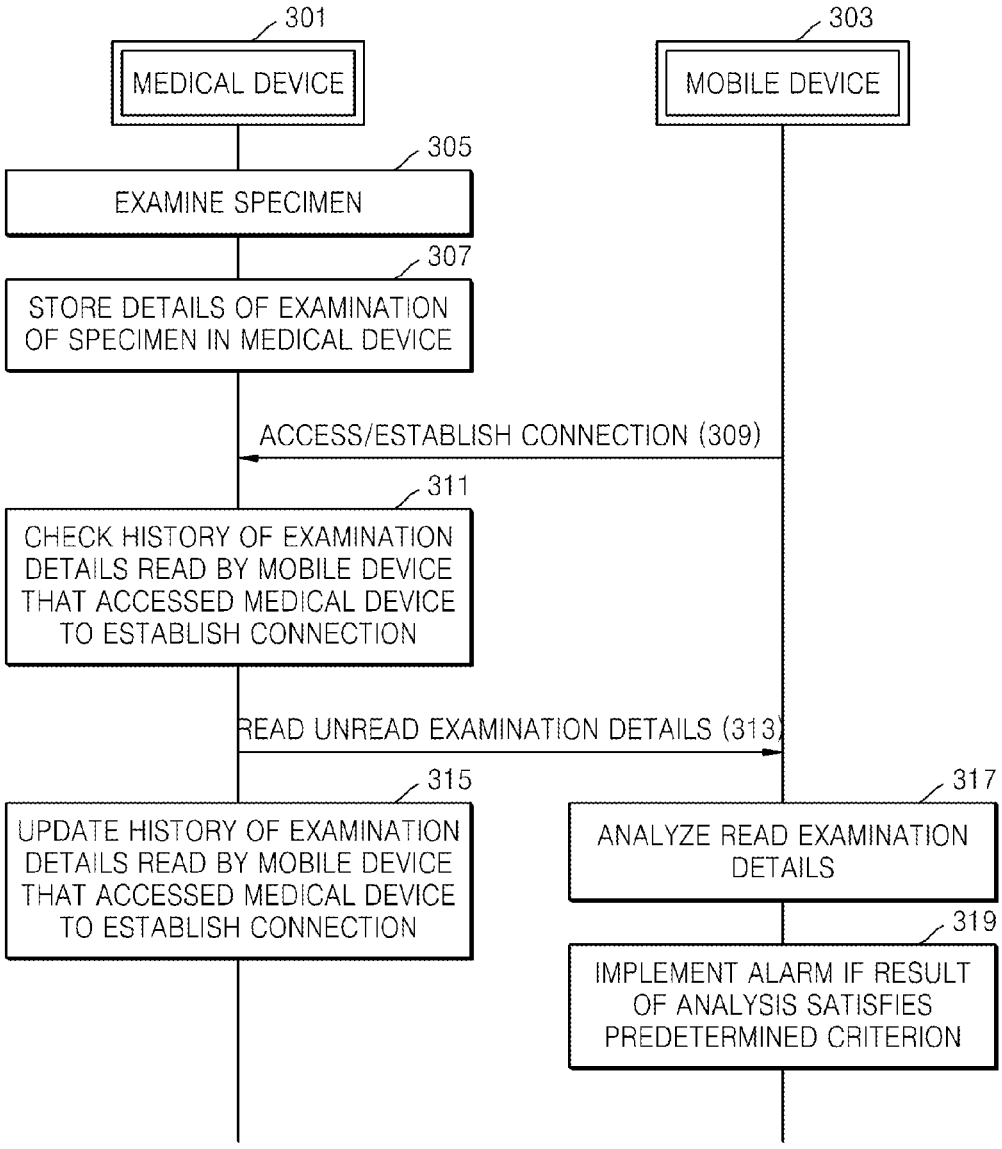

301
MEDICAL DEVICE
303
MOBILE DEVICE
305
EXAMINE SPECIMEN
307
STORE DETAILS OF EXAMINATION OF SPECIMEN IN MEDICAL DEVICE
ACCESS/ESTABLISH CONNECTION (309)
311
CHECK HISTORY OF EXAMINATION DETAILS READ BY MOBILE DEVICE THAT ACCESSED MEDICAL DEVICE TO ESTABLISH CONNECTION
READ UNREAD EXAMINATION DETAILS (313)
315
UPDATE HISTORY OF EXAMINATION DETAILS READ BY MOBILE DEVICE THAT ACCESSED MEDICAL DEVICE TO ESTABLISH CONNECTION
317
ANALYZE READ EXAMINATION DETAILS
319
IMPLEMENT ALARM IF RESULT OF ANALYSIS SATISFIES PREDETERMINED CRITERION

FIG. 4

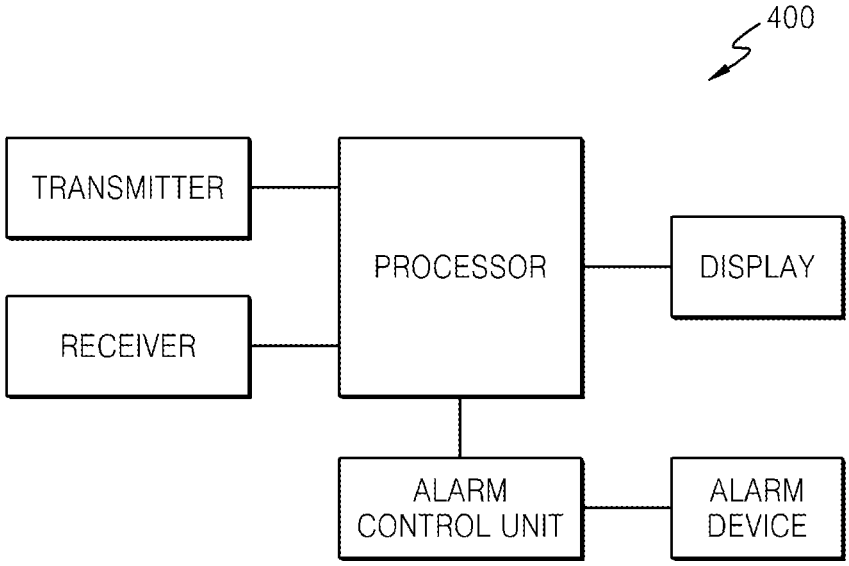

400
TRANSMITTER
RECEIVER
PROCESSOR
DISPLAY
ALARM CONTROL UNIT
ALARM DEVICE

FIG. 5

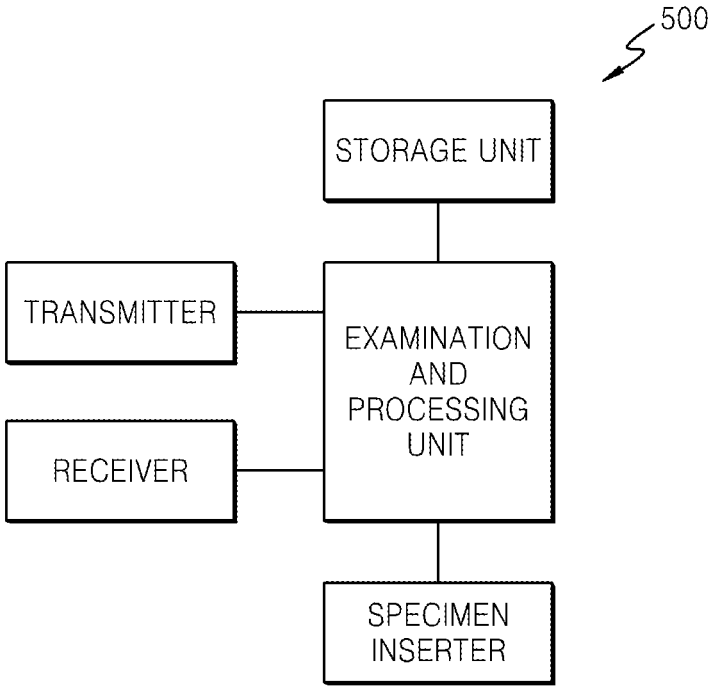

500
STORAGE UNIT
TRANSMITTER
RECEIVER
EXAMINATION AND PROCESSING UNIT
SPECIMEN INSERTER

FIG. 6

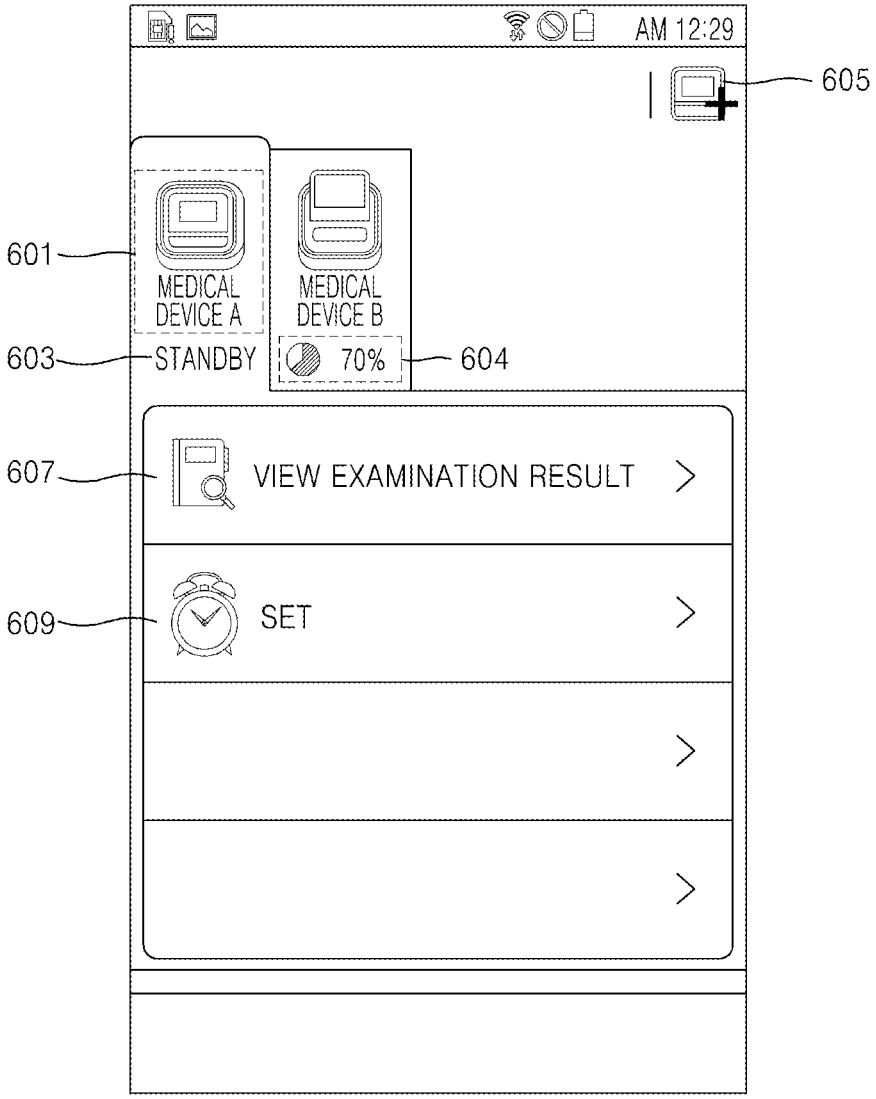

AM 12:29
605
601
MEDICAL DEVICE A
MEDICAL DEVICE B
603
STANDBY
70%
604
607
VIEW EXAMINATION RESULT
609
SET

FIG. 7

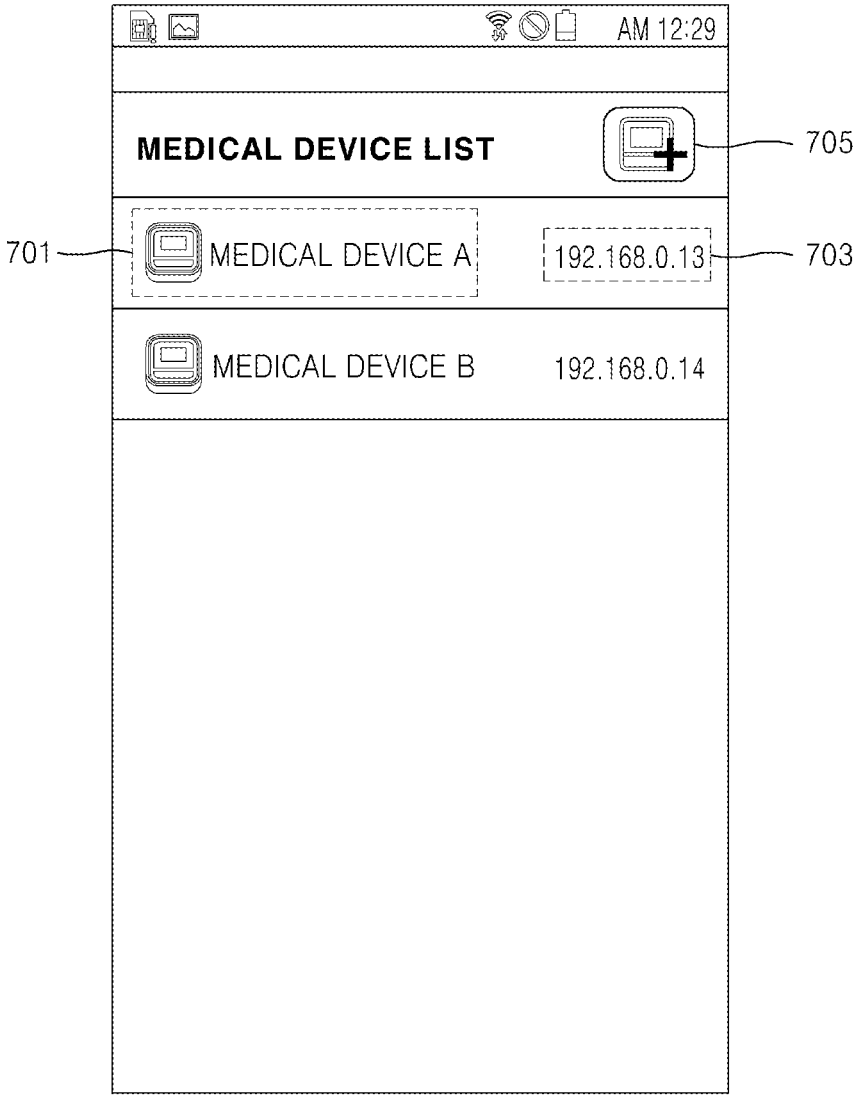

AM 12:29
MEDICAL DEVICE LIST
705
701
MEDICAL DEVICE A
192.168.0.13
703
MEDICAL DEVICE B
192.168.0.14

FIG. 8

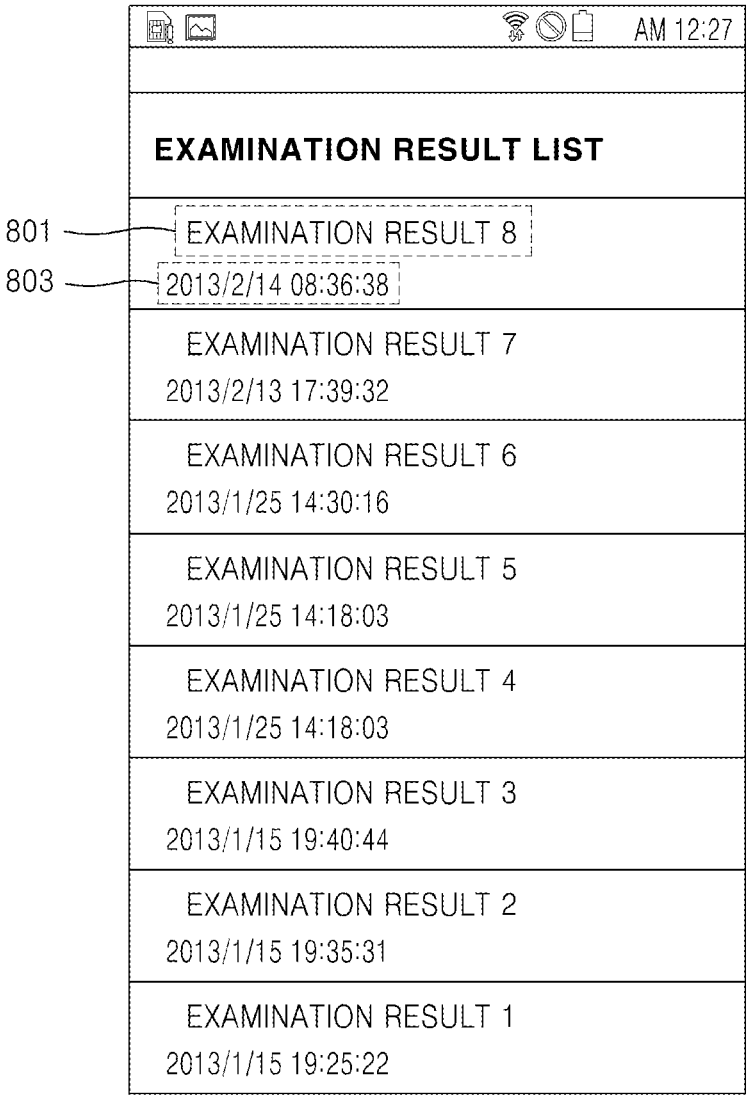

AM 12:27
EXAMINATION RESULT LIST
801
EXAMINATION RESULT 8
803
2013/2/14 08:36:38
EXAMINATION RESULT 7
2013/2/13 17:39:32
EXAMINATION RESULT 6
2013/1/25 14:30:16
EXAMINATION RESULT 5
2013/1/25 14:18:03
EXAMINATION RESULT 4
2013/1/25 14:18:03
EXAMINATION RESULT 3
2013/1/15 19:40:44
EXAMINATION RESULT 2
2013/1/15 19:35:31
EXAMINATION RESULT 1
2013/1/15 19:25:22

FIG. 9

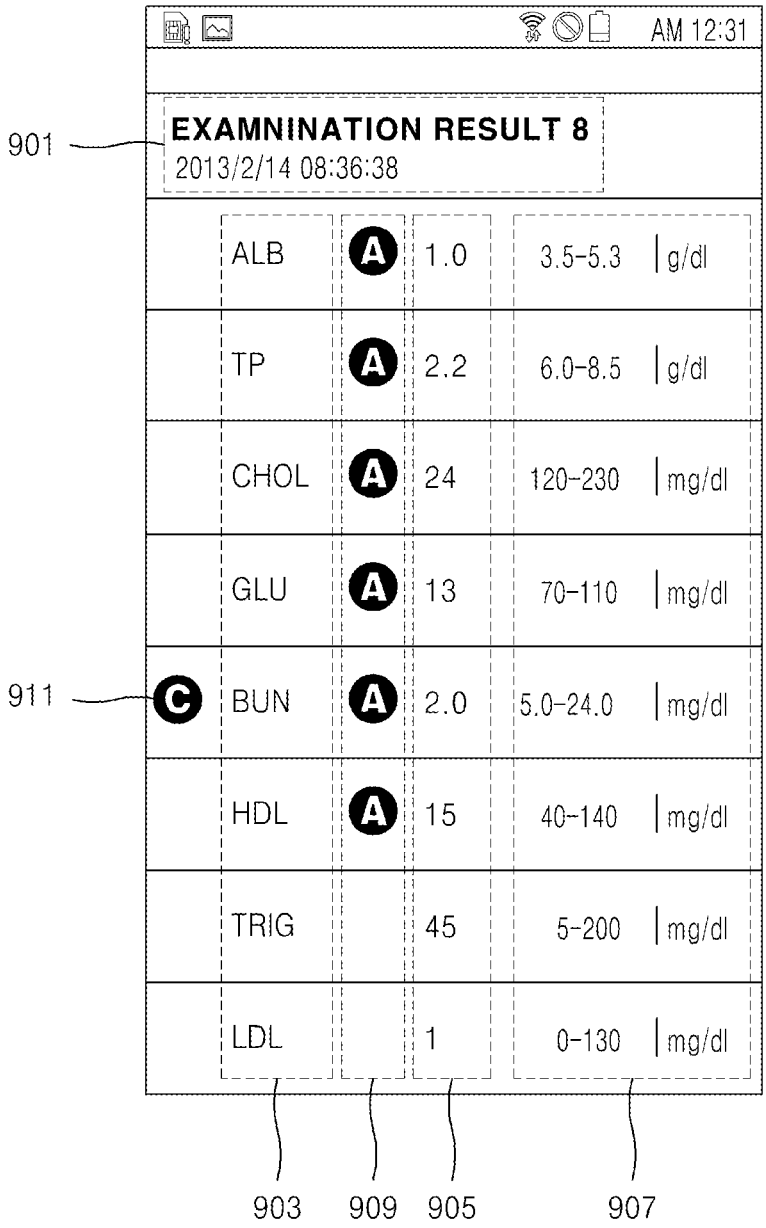

AM 12:31
EXAMNINATION RESULT 8
2013/2/14 08:36:38
901
ALB A 1.0 3.5-5.3 g/dl
TP A 2.2 6.0-8.5 g/dl
CHOL A 24 120-230 mg/dl
GLU A 13 70-110 mg/dl
911
C BUN A 2.0 5.0-24.0 mg/dl
HDL A 15 40-140 mg/dl
TRIG 45 5-200 mg/dl
LDL 1 0-130 mg/dl
903
909
905
907

FIG. 10A

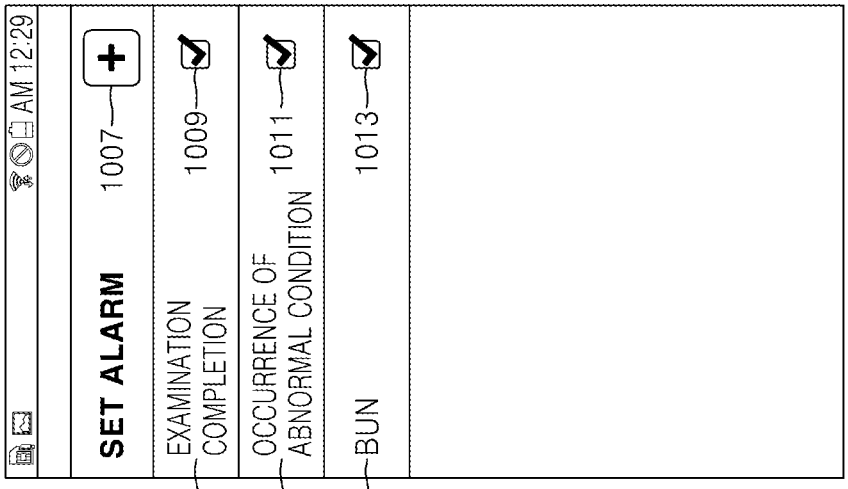


FIG. 10B

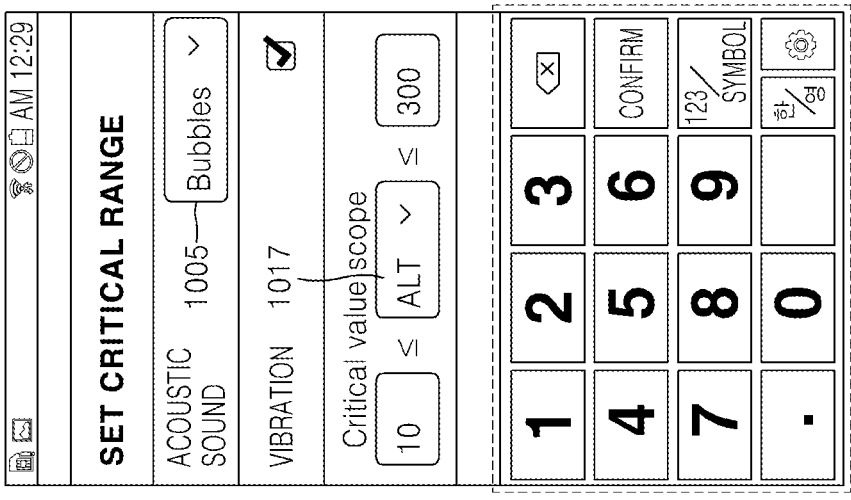


FIG. 10C

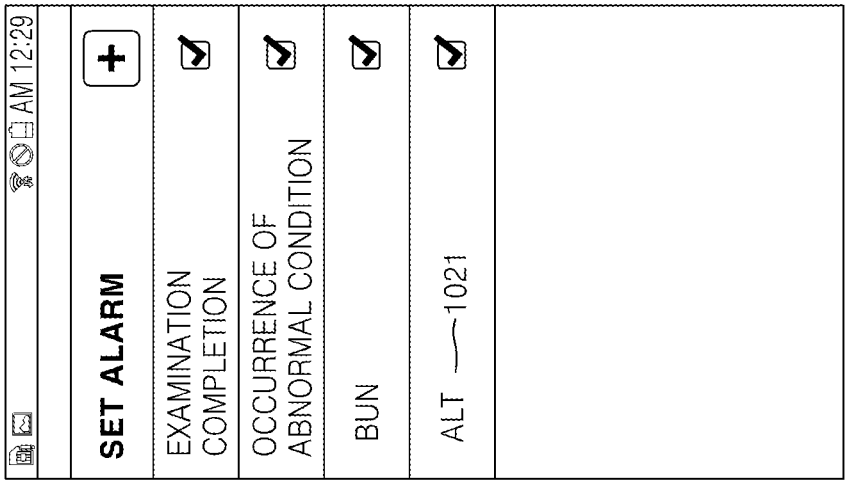


FIG. 11

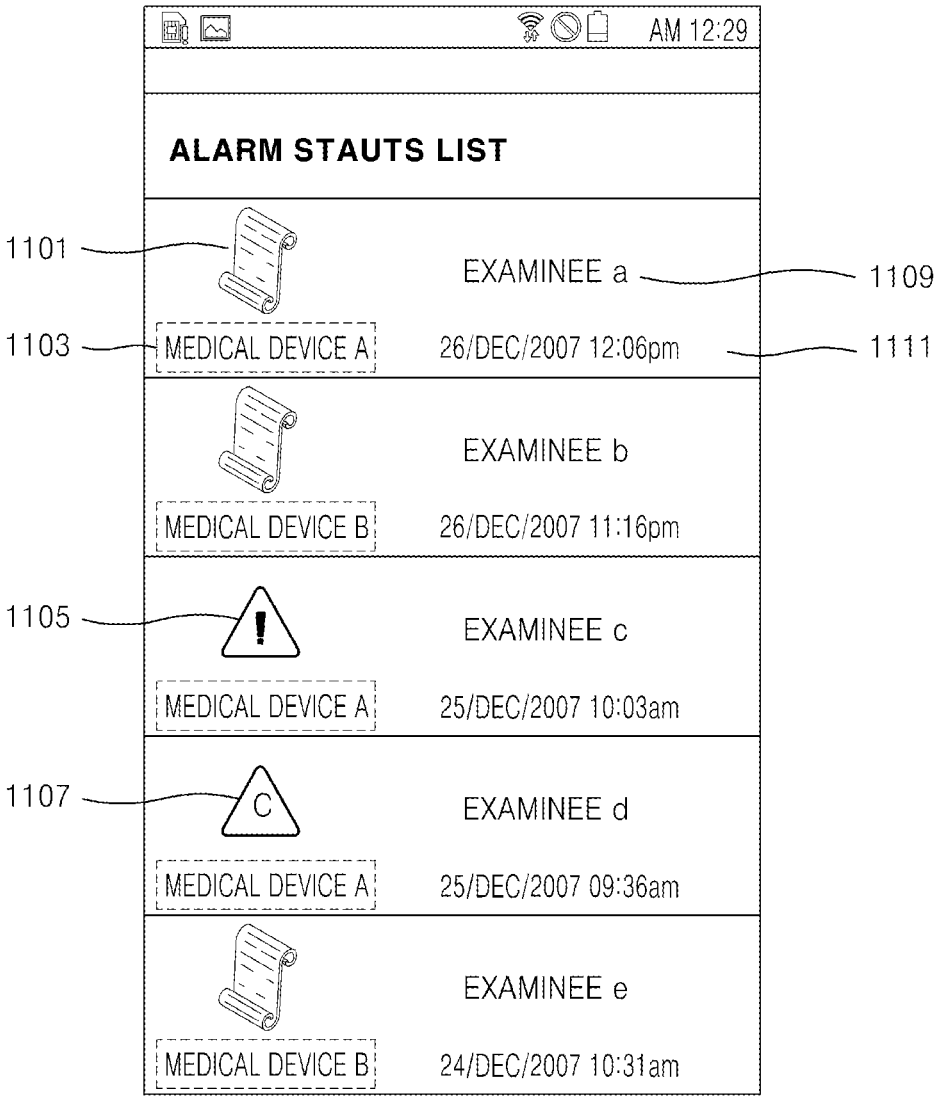

AM 12:29
ALARM STAUTS LIST
1101
EXAMINEE a
1109
1103
MEDICAL DEVICE A
26/DEC/2007 12:06pm
1111
EXAMINEE b
MEDICAL DEVICE B
26/DEC/2007 11:16pm
1105
EXAMINEE c
MEDICAL DEVICE A
25/DEC/2007 10:03am
1107
C
EXAMINEE d
MEDICAL DEVICE A
25/DEC/2007 09:36am
EXAMINEE e
MEDICAL DEVICE B
24/DEC/2007 10:31am

FIG. 12A

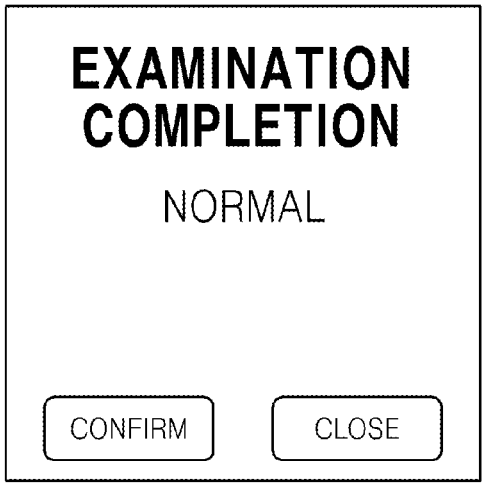


FIG. 12B

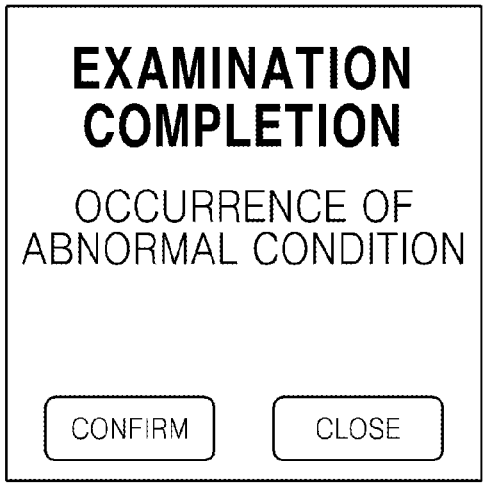


FIG. 12C

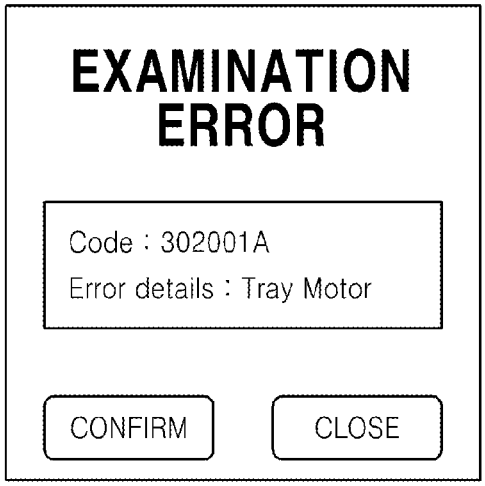
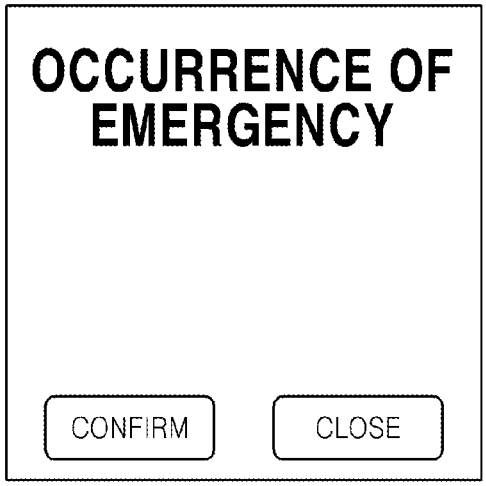


FIG. 12D



METHOD AND SYSTEM FOR IMPLEMENTING ALARMS FOR MEDICAL DEVICE THROUGH MOBILE DEVICE

RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application No. 61/767,978, filed on Feb. 22, 2013, in the US Patent Office and Korean Patent Application No. 10-2013-0044881, filed on Apr. 23, 2013, in the Korean Intellectual Property Office, the disclosures of which are incorporated herein in their entireties by reference.

BACKGROUND

1. Field

One or more exemplary embodiments relate to a method and system for implementing alarms for a medical device through a mobile device.

2. Description of the Related Art

Ubiquitous healthcare (U-Health) integrates information technology (IT) with health and medical care to provide healthcare services such as prevention, diagnosis, treatment, and follow-up management of diseases. With dissemination of the U-Health concept, an increasing number of medical devices that are used inside or outside a hospital tend to be connected to one another via a network. However, a user of a medical device for providing examination and diagnosis functions is inconvenienced in having to stay near the medical device during the length of examination. Thus, an alarm function of a medical device has been implemented using a warning light or an acoustic sound so that a user may recognize completion of examination or occurrence of errors in the medical device even when being located away from the medical device. In addition, when necessary, alarm information of a medical device may be transmitted to a user's PC. However, an alarm using a warning light or acoustic sound has a limitation in a distance to which a user can perceive the alarm. Furthermore, in order to transmit alarm information to a PC, a connection for transmitting the alarm information has to be continuously maintained. This may not only cause the waste of medical device's communication resources but also hamper concentration of resources on an examination function that is a basic function of the medical device.

FIGS. **1**A and **1**B are schematic diagrams of conventional configurations in which a medical device **101** or **107** implements an alarm.

Referring to FIG. **1**A, when a cause for an alarm occurs in the medical device **101**, the medical device **101** notifies a user side **105** of occurrence of the cause for alarm through a warning light or speaker **103**. According to this conventional method, a user is inconvenienced in having to stay within a range in which the user is able to see the warning light or perceive an alarm sound output from the speaker.

Referring to FIG. **1**B, when a cause for an alarm occurs in the medical device **107**, the medical device **107** transmits an alarm notification to an in-house server **109** that will then deliver the alarm notification to a user's PC **111** so that the user's PC **111** implement an alarm. However, in this case, since a connection for transmitting alarm information to the user's PC **111** has to be maintained continuously, communication resources of the medical device may be wasted, and resources cannot be concentrated in a main function, i.e., an examination function of the medical device **107**.

SUMMARY

One or more exemplary embodiments include a method and system for effectively implementing alarms for a medical device through a mobile device.

One or more exemplary embodiments include a computer-readable recording medium having recorded thereon a program for executing the method on a computer.

One or more exemplary embodiments include an application for providing an alarm through a mobile device that is connected directly to a medical device.

One or more exemplary embodiments include a system configured to not only provide an alarm notifying simple examination-completion or error-occurrence but also individually set alarm conditions for each examinee. In this case, it is possible to set a range that is considered important in the result of examination of an individual examinee and process a situation that falls within the set range as emergency alarm.

Additional aspects will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the presented embodiments.

According to one or more exemplary embodiments, a method of implementing an alarm for a medical device through a mobile device includes: storing details of examination of a specimen (hereinafter, referred to as examination details) in the medical device, wherein the storing is performed by the medical device; accessing the medical device and establishing a connection with the medical device, wherein the accessing and the establishing of the connection is performed by the mobile device; reading the examination details stored in the medical device, wherein the reading is performed by the mobile device; analyzing the read examination details, wherein the analyzing is performed by the mobile device; and implementing an alarm if the result of analysis satisfies a predetermined criterion, wherein the implementing is performed by the mobile device.

The accessing may be performed for every predetermined period.

The connection may be maintained only while the mobile device accesses the medical device to establish the connection with the medical device and reads the examination details from the medical device.

If the result of analysis satisfies the predetermined criterion, the result of the examination of the specimen (hereinafter, referred to as an examination result) may deviate from a preset range, or the examination of the specimen may be completed.

The preset range may be set individually for each examination item of an individual examinee.

When the examination result deviates from the preset range and falls within a critical range, an alarm may be implemented, and at the same time an alarm notification may be transmitted to a predetermined destination.

The medical device may recognize a plurality of mobile devices to record therein a history that examination details have been read by each of the mobile devices and allow the mobile device to read only examination details that have not been read by the mobile device.

The alarm may be implemented as at least one of a bell sound, music, an acoustic sound, a vibration, flashing light, and a popup window.

According to one or more exemplary embodiments, a mobile device for implementing an alarm for a medical device includes: a transmitter for transmitting requests for establishing a connection with the medical device and for reading details of examination of a specimen (hereinafter, referred to as "examination details") stored in the medical device; a receiver for receiving from the medical device a response to accept the request for establishing the connection with the medical device and the examination details; a processor that analyzes the received examination details and

determines whether the result of analysis of the examination details satisfies a predetermined criterion; and an alarm unit for implementing an alarm if the result of analysis satisfies the predetermined criterion.

The request for establishing the connection with the medical device may be made for every predetermined period.

The connection may be maintained only while the mobile device establishes the connection with the medical device and receives the examination details from the medical device.

If the result of analysis satisfies the predetermined criterion, the result of the examination of the specimen (hereinafter, referred to as an examination result) may deviate from a preset range, or the examination of the specimen may be completed.

The preset range may be set individually for each examination item of an individual examinee.

When the examination result deviates from the preset range and falls within a critical range, an alarm may be implemented, and at the same time an alarm notification may be transmitted to a predetermined destination.

The mobile device may be set to read only examination details that have not been read thereby.

The alarm may be implemented as at least one of a bell sound, music, an acoustic sound, a vibration, flashing light, and a popup window.

According to one or more exemplary embodiments, a medical device for implementing an alarm through a mobile device includes: a specimen inserter for inserting the specimen; an examination and processing unit that examines the specimen and processes the result of examination of the specimen (hereinafter, referred to as an examination result); a storage unit for storing the examination result; a receiver for receiving requests for establishing a connection and for reading details of the examination of the specimen (hereinafter, referred to as examination details) from the mobile device; and a transmitter for transmitting a response that accepts the request for establishing the connection together with the examination details.

The request for establishing the connection may be made for every predetermined period.

The connection may be maintained only while the mobile device establishes the connection with the medical device and receives the examination details from the medical device.

The transmitter may transmit the examination result defined as particular values or ranges of values.

When the examination result deviates from a preset range and falls within a critical range, the transmitter may transmit an alarm notification to a predetermined destination.

The medical device may recognize a plurality of mobile devices to record therein a history that the examination details have been read by each of the mobile devices and allow the mobile device to read only examination details that have not been read by the mobile device.

The mobile device may analyze the received examination details and implement an alarm if the result of analysis of the examination details satisfies a predetermined criterion.

The alarm may be implemented as at least one of a bell sound, music, an acoustic sound, a vibration, flashing light, and a popup window.

According to one or more exemplary embodiments, a non-transitory computer-readable recording medium has recorded thereon a program for executing the method on a computer.

As described above, upon completion of examination of a specimen using a medical device, or when the examination result deviates from a preset range, an alarm may be generated through a mobile device, thereby eliminating the need for an examiner to continuously stay near or an examiner's PC to be connected to the medical device during the examination. Furthermore, a connection between the mobile device and the medical device is maintained only while the mobile device accesses the medical device to establish a connection therewith and reads details of examination from the medical device, thereby reducing burden on a function of the medical device other than an examination function. In other words, the medical device may be dedicated to performing its main function, i.e., an examination function by using resources of a mobile device instead of resources of the medical device to implement an alarm function. Furthermore, when the examination result deviates from a preset range to fall within a critical range, an emergency notification may be transmitted to a predetermined destination while an alarm is being implemented, thus allowing medical personnel to immediately identify a critical condition in the examination result. Furthermore, a response to the examination result may be set differently for an individual user, thereby allowing medical personnel to more effectively respond to the examination result. In addition, it is possible to set alarms differently across a plurality of mobile devices that are connected to the medical device, thereby allowing different settings and notifications of alarms in response to the same examination result, as needed by a diagnostic staff (or a user of a mobile device).

BRIEF DESCRIPTION OF THE DRAWINGS

These and/or other aspects will become apparent and more readily appreciated from the following description of the exemplary embodiments, taken in conjunction with the accompanying drawings, and reference numerals therein denote structural elements, in which:

FIGS. **1**A and **1**B are conceptual diagrams of conventional methods of implementing alarms for medical devices;

FIG. **2** is a flowchart of a method of implementing an alarm for a medical device through a mobile device, according to an exemplary embodiment;

FIG. **3** is a schematic diagram of a system for implementing an alarm for a medical device through a mobile device, according to an exemplary embodiment;

FIG. **4** is a schematic diagram of a mobile device through which an alarm for a medical device is implemented, according to an exemplary embodiment;

FIG. **5** is a schematic diagram of a medical device for implementing an alarm through a mobile device, according to an exemplary embodiment;

FIG. **6** is a schematic diagram of a screen of a mobile device on which a medical device alarm application runs, according to an exemplary embodiment;

FIG. **7** is a schematic diagram of a screen of a mobile device that displays a medical device list or appears when a button for registering an unregistered medical device is selected, according to an exemplary embodiment;

FIG. **8** is a schematic diagram of a screen of a mobile device that appears when an item 'view examination results' shown in FIG. **6** is selected, according to an exemplary embodiment;

FIG. **9** is a schematic diagram of a screen of a mobile device that appears when 'examination result **8**' shown in FIG. **8** is selected, according to an exemplary embodiment;

FIGS. **10**A through **10**C are schematic diagrams of screens of a mobile device that appear when an item 'set' shown in FIG. **6** is selected, according to an exemplary embodiment;

FIG. **11** is a schematic diagram of a screen of a mobile device that displays an alarm status list, according to an exemplary embodiment; and

FIGS. **12**A through **12**D are schematic diagrams of message windows that pop up on a screen of a mobile device when an alarm is implemented as a popup window.

DETAILED DESCRIPTION

The terms used in this specification are general terms currently widely used in the art in consideration of functions in regard to the present invention, but the terms may vary according to the intention of one of ordinary skill in the art, precedents, or the occurrence of new technologies in the art. Also, specific terms may be selected by the applicant, and in this case, the detailed meaning thereof will be described in the detailed description of the invention. Thus, the terms used in the specification should be understood not as simple names but based on their meanings and the overall description of the invention.

Throughout the specification, it will also be understood that when a component "includes" an element, unless there is another opposite description thereto, the component does not exclude another element but may further include another element. In addition, terms such as " . . . unit", " . . . module", or the like refer to units that perform at least one function or operation, and the units may be implemented as hardware or software or as a combination of hardware and software. Expressions such as "at least one of," when preceding a list of elements, modify the entire list of elements and do not modify the individual elements of the list.

Exemplary embodiments of the present invention will now be described more fully hereinafter with reference to the accompanying drawings.

FIG. **2** is a flowchart of a method of outputting an alarm for a medical device through a mobile device, according to an exemplary embodiment. The method according to the present embodiment includes operations performed by a mobile device **400** of FIG. **4** and a medical device **500** of FIG. **5** in a time series. Thus, although omitted hereinafter, the descriptions with respect to configurations shown in FIGS. **4** and **5** may also apply to the method of FIG. **2**.

Details of examination of a sample to be inspected (hereinafter, referred to as a 'specimen') is stored in a medical device (S**201**). The specimen may generally include various biological tissues that are extracted from an examinee's body. A representative specimen may be the examinee's blood, but is not limited thereto. The specimen may be any specimen other than biological tissue extracted from the examinee as long as it can be inspected by the medical device. The details of examination that are stored in the medical device (hereinafter, referred to as "examination details") may include examination items, examination result values, completion or incompletion of the examination, occurrence of abnormal conditions, and falling within a critical range. The examination details may be stored in a memory installed in the medical device.

The mobile device establishes a connection (Operation **203**) with the medical device to have access therewith. The mobile device is connected to the medical device via wired or wireless communication networks such as in-house networks (Local Area Network (LAN) and Wireless Fidelity (WiFi)) or public networks (3G and 4G). The networks are not limited to a particular type of network. The mobile device may connect to the medical device at irregular time intervals according to user manipulation or at every predetermined period set by the user, i.e., user preferences or settings. The connection between the mobile device and the medical device may be maintained only while the mobile device is connected to the medical device to have access therewith and reads the examination details from the medical device. Limiting the duration for the connection between the medical device and the mobile device in this way may prevent the waste of communication resources due to continuously maintaining the connection therebetween. The mobile device may not be connected to only one medical device but may be connected to a plurality of medical devices to have access to the plurality of medical devices. In an exemplary embodiment, the connections may be simultaneous or may not be simultaneous.

The medical device checks a history of the examination details have been read by the mobile device that established a connection therewith and determines whether there are new examination details that have not been read by the mobile device (Operation **205**). The medical device may be configured to recognize a plurality of mobile devices and record therein a history of examination details have been read by each of the mobile devices and to allow the mobile device to read only the new examination details that have not been read by the mobile device.

If there are new examination details not read by the mobile device, the mobile device reads the not-read examination details stored in the medical device (Operation **207**).

The mobile device analyzes the read examination details (Operation **209**). The examination details to be analyzed may include all pieces of information contained in the read examination details, such as examination items, examination result values, completion or incompletion of the examination, occurrence of abnormal conditions, and falling within a critical range.

If the result of analysis of examination details satisfies a predetermined criterion, the mobile device implements an alarm (Operation **211**). If the result of analysis satisfies the predetermined criterion, the result of examination of the specimen (hereinafter, referred to as an "examination result") may deviate from a preset range (e.g, occurrence of an abnormal condition or the examination result falling within a critical range), or the examination of the specimen may be completed. If the examination result deviates from the preset range, it may be classified as 'occurrence of a simple abnormal condition' or 'occurrence of a critical condition' according to user's settings. The preset range for the examination result may be individually set for each examination item of an individual examinee.

The alarm may be implemented using various ways including a bell sound, music, an acoustic sound, a vibration, flashing light, and a popup window. The alarm may be output in different ways according to situations classified as 'occurrence of a simple abnormal condition' 'occurrence of a critical condition', and 'completion of the examination.' FIGS. **12**A through **12**D illustrate message windows that pop up on a screen of a mobile device when an alarm is implemented as a popup window. FIGS. **12**A and **12**B are alarm message windows that pop up on the screen of the mobile device when the examination is normally completed and when an abnormal condition occurs in the examination result, respectively. FIGS. **120** and **12**D are alarm message windows that pop up on the screen of the mobile device upon occurrence of an error in a medical device and upon occurrence of an emergency or a critical condition in the examination result, respectively. If the examination result deviates from a preset range to fall within a critical range, an alarm may be output, and at the same time an emergency notification may be transmitted to a predetermined destination such as a hospital emergency room or a fire station. In this case, the emergency notification may be transmitted using various methods such as a Short Message Service (SMS) or an emergency call.

FIG. **3** is a schematic diagram of a system for implementing an alarm for a medical device **301** through a mobile device **303**, according to an exemplary embodiment.

Referring to FIG. **3**, the medical device **301** performs examination on a specimen (Operation **305**) and stores examination details therein (Operation **307**). The specimen may generally include various biological tissues that are extracted from an examinee's body. A representative specimen may be the examinee's blood, but is not limited thereto. The specimen may be any specimen other than biological tissue extracted from the examinee as long as it can be inspected by the medical device **301**. The stored examination details may include examination items, examination result values, completion or incompletion of the examination, occurrence of abnormal conditions, and falling within a critical range. The examination details may be stored in a memory installed in the medical device **301**.

The mobile device **303** has set up the connection to the medical device **301** to have access therewith (Operation **309**). The mobile device **303** accesses and is connected to the medical device **301** via wired or wireless communication networks such as in-house networks (LAN and WiFi) or public networks (3G and 4G). The networks are not limited to a particular type of network. The mobile device may connect to the medical device at irregular time intervals according to user manipulation or at every predetermined period set by the user. The connection between the mobile device **303** and the medical device **301** may be maintained only while the mobile device **303** accesses the medical device to obtain information therefrom and reads the examination details from the medical device **301**. Limiting the duration for the connection between the medical device **301** and the mobile device **303** in this way may prevent the waste of communication resources due to continuously maintaining the connection therebetween. The mobile device **303** may not be connected to only one medical device but may be connected to a plurality of medical devices to access therewith.

The medical device **301** checks a history of the examination details that are read by the mobile device **303** that established a connection therewith, and determines whether there are new examination details that are not read by the mobile device **303** (Operation **311**). The medical device **301** may be configured to recognize a plurality of mobile devices and record therein a history that examination details have been read by each of the mobile devices and to allow the mobile device to read only the new examination details that have not been read by the mobile device.

If there are new examination details not read by the mobile device **303**, the mobile device **303** reads the unread examination details stored in the medical device **301** (Operation **313**).

The medical device **301** updates a history of examination details read by the mobile device **303** (Operation **315**). In other words, the medical device **301** changes the read examination details from a not-read status to a read status.

The mobile device **303** analyzes the read examination details (Operation **317**). The examination details to be analyzed may include all pieces of information contained in the read examination details, such as examination items, examination result values, completion or incompletion of the examination, occurrence of abnormal conditions, and falling within a critical range.

If the result of analysis of examination details satisfies a predetermined criterion, the mobile device outputs an alarm (Operation **319**). If the result of analysis satisfies the predetermined criterion, the examination result may deviate from a preset range (e.g, occurrence of an abnormal condition, or the examination result falling within a critical range), or the examination of the specimen may be completed. If the examination result deviates from the preset range, it may be classified as 'occurrence of a simple abnormal condition' or 'occurrence of a critical condition' according to user's settings. The preset range for the examination result may be individually set for each examination item of an individual examinee.

The alarm may be implemented using various ways including a bell sound, music, an acoustic sound, a vibration, flashing light, and a popup window. The alarm may be output in different ways according to situations classified as 'occurrence of a simple abnormal condition' 'occurrence of a critical condition', and 'completion of the examination,' as shown in FIGS. **12**A through **12**D that illustrate message windows that pop up on a screen of a mobile device when an alarm is implemented as a popup window. FIGS. **12**A and **12**B are alarm message windows that pop up on the screen of the mobile device when the examination is normally completed and when an abnormal condition occurs in the examination result, respectively. FIGS. **12**C and **12**D are alarm message windows that pop up on the screen of the mobile device upon occurrence of an error in a medical device and upon occurrence of an emergency/a critical condition in the examination result, respectively. If the examination result deviates from a preset range to fall within a critical range, an alarm may be output, and an emergency notification may also be transmitted to a predetermined destination such as a hospital emergency room or a fire station. In this case, the emergency notification may be transmitted using various methods such as an SMS or an emergency call.

FIG. **4** is a schematic diagram of a mobile device **400** through which an alarm for a medical device is output, according to an exemplary embodiment. The mobile device **400** according to the present embodiment includes a processor, a transmitter, a receiver, an alarm control unit, an alarm device, and a display. All of the aforementioned components of the mobile device may be implemented as hardware components. In other exemplary embodiments, some of the aforementioned components may be implemented as software components or software modules.

The transmitter transmits to the medical device requests for establishing a connection with the medical device and for reading details of examination of a specimen (hereinafter, referred to as "examination details") stored in the medical device. The requests are made via wired or wireless communication networks such as in-house networks (LAN and WiFi) or public networks (3G and 4G). The networks are not limited to a particular type of network. When necessary, the requests may be made through a connection between the mobile device **400** and the medical device via Bluetooth. The request for establishing a connection with the medical device may be transmitted at irregular time intervals according to user manipulation or at every predetermined period set by the user. The requested connection may be maintained only while the mobile device **400** establishes a connection with the medical device and receives the examination details therefrom. Limiting the duration for the connection between the medical device and the mobile device **400** in this way may prevent the waste of communication resources due to continuously maintaining the connection therebetween. The mobile device **400** may not be connected to only one medical device but may be connected to a plurality of medical devices to access therewith. In other words, the mobile device **400** may transmit a request for establishing a connection to the plurality of medical devices.

The receiver receives a response to accept the request for establishing a connection with the medical device and the examination details from the medical device. When the

response is received from the medical device, a connection between the mobile device **400** and the medical device is established, and the examination details are received through the connection therebetween.

The processor analyzes the examination details and determines whether the result of analysis of the examination details satisfies a predetermined criterion. The examination details to be analyzed may include all pieces of information contained in the read examination details, i.e., examination items, examination result values, completion or incompletion of the examination, occurrence of abnormal conditions, falling within a critical range, etc. If the result of analysis satisfies a predetermined criterion, the examination result may deviate from a preset range (e.g., occurrence of an abnormal condition, or the examination result falling within a critical range), or the examination of the specimen may be completed. If the examination result deviates from the preset range, it may be classified as 'occurrence of a simple abnormal condition' or 'occurrence of a critical condition' according to user's settings. The preset range for the examination result may be individually set for each examination item of an individual examinee. The processor may be configured to allow the mobile device **400** to read only examination details that have not been read by the mobile device. If there are examination details not read by the mobile device, the mobile device **400** reads the unread examination details stored in the medical device.

When the result of analysis satisfies the predetermined criterion, the alarm control unit implements an alarm through an alarm device. The alarm may be implemented using various ways including a bell sound, music, an acoustic sound, a vibration, flashing light, and a popup window. The alarm may be output in different ways according to situations classified as 'occurrence of a simple abnormal condition' occurrence of a critical condition', and 'completion of the examination,' as shown in FIGS. **12**A through **12**D that illustrate message windows that pop up on a screen of a mobile device when an alarm is implemented as a popup window. If the examination result deviates from a preset range to fall within a critical range, an alarm may be output, and an emergency notification may also be transmitted to a predetermined destination such as a hospital emergency room or a fire station. In this case, the emergency notification may be transmitted using various methods such as an SMS or an emergency call.

The display may display a user interface related to an alarm for the medical device and information about a progress of examination of a specimen.

FIG. **5** is a schematic diagram of a medical device **500** for implementing an alarm through a mobile device, according to an exemplary embodiment. Referring to FIG. **5**, the medical device **500** according to the present embodiment includes a specimen inserter, an examination and processing unit, a storage unit, a receiver, and a transmitter. As with the exemplary embodiment described in FIG. **4**, each of these components may be implemented in hardware or software.

The specimen inserter is configured to insert a specimen to be inspected. The specimen may generally include various biological tissues that are extracted from an examinee's body. A representative specimen may be the examinee's blood, but is not limited thereto. The specimen may be any specimen other than biological tissue extracted from the examinee as long as it can be inspected by the medical device **500**.

The examination and processing unit performs examination of a specimen in the same manner that medical examination equipment generally performs and processes the examination result. The examination result means details of the examination including examination items, examination result values, completion/incompletion of the examination, occurrence of abnormal conditions, and falling within a critical range, and is symmetrically arranged and processed. The examination and processing unit may be configured to recognize a plurality of mobile devices and record therein a history that the examination details have been read by each of the mobile devices and to allow the mobile device to read only new examination details that have not been read by the mobile device. In other words, if there are new examination details not read by the mobile device, the mobile device is allowed to read the unread examination details stored in the medical device **500**.

The storage unit stores the examination result processed by the examination and processing unit.

The receiver receives requests for establishing a connection with the medical device **500** and for reading examination details. The requests may be received via wired or wireless communication networks such as in-house networks (LAN and WiFi) or public networks (3G and 4G). The networks are not limited to a particular type of network. When necessary, the requests may be received through a connection between the mobile device and the medical device **500** via Bluetooth. The request for establishing a connection with the medical device may be transmitted at irregular time intervals according to user manipulation or at every predetermined period set by the user. The requested connection may be maintained only while the mobile device establishes a connection with the medical device **500** and receives the examination details therefrom. Limiting the duration for the connection between the medical device and the mobile device **400** in this way may prevent the waste of communication resources due to continuously maintaining the connection therebetween. The medical device **500** may not be connected to only one mobile device but establish a plurality of connections with a plurality of mobile devices. Alarms may be set differently across a plurality of mobile devices that are connected to the medical device **500**, thereby allowing different settings and notifications of alarms in response to the same examination result, as needed by a diagnostic staff (or a user of a mobile device).

The transmitter transmits to the mobile device a response that accepts a request for establishing a connection with the medical device **500** together with examination details. When the mobile device receives the response from the medical device **500**, a connection between the mobile device and the medical device **500** is established, and the examination details are transmitted through the connection therebetween. In this case, the examination details include examination result defined as particular values or ranges of values. If the examination result deviates from a preset range to fall within a critical range, the transmitter may transmit an emergency notification to a predetermined destination such as a hospital emergency room or a fire station. In this case, the emergency notification may be transmitted using various methods such as an SMS or an emergency call.

Upon receipt of the examination details from the medical device **500**, the mobile device analyzes the examination details and implements an alarm if the result of analysis satisfies a predetermined criterion. The alarm may be implemented using various ways including a bell sound, music, an acoustic sound, a vibration, flashing light, and a popup window. The alarm may be output in different ways according to situations classified as 'occurrence of a simple abnormal condition' 'occurrence of a critical condition', and 'completion of the examination,' as shown in FIGS. **12**A through **12**D that illustrate message windows that pop up on a screen of a mobile device when an alarm is implemented as a popup window. If the examination result deviates from a preset

range to fall within a critical range, an alarm may be output, and an emergency notification may also be transmitted to a predetermined destination such as a hospital emergency room or a fire station. In this case, the emergency notification may be transmitted using various methods such as an SMS or an emergency call.

FIG. **6** is a schematic diagram of a screen of a mobile device on which a medical device alarm application runs, according to an exemplary embodiment.

The mobile device may establish connections with a plurality of medical devices. In the present exemplary embodiment, the mobile device currently establishes connections with two medical devices (medical device A and medical device B). The medical devices A and B may be distinguished by their corresponding icons and a reference numeral **601**. In addition, current statuses **603** and **604** of the medical device A **601** and the medical device B may be displayed. Although the medical device A **601** is currently in a standby status, the current status **603** of the medical device A **601** may be an off status or a disconnected status, or may be represented in various other ways such as a rate of progress of examination. According to the present embodiment, the current status **604** of the medical device B is an in-progress status and represents an examination progress rate of 70%. When the medical apparatus A is selected by using various control methods, e.g., by a user touching the screen, pressing a button, and moving a cursor, items 'view examination results' and 'set' **607** and **609** for the medical apparatus A are displayed on the screen. In addition, a registered or unregistered medical device list or a button **605** for registering an unregistered medical device may be displayed on the screen.

FIG. **7** is a schematic diagram of a screen of a mobile device that displays a medical device list or appears when the button **605** shown in FIG. **6** for registering an unregistered medical device is selected, according to an exemplary embodiment. Medical devices A and B connected to the mobile device are distinguished by their corresponding icons and reference numeral **701** and displayed on the medical device list together with IP addresses **703** thereof. In addition, a separate button **705** for registering an unregistered medical device may be displayed on the screen. When the separate button **705** is selected by various control methods, e.g., by a user touching the screen, pressing a button, and moving a cursor, a list of unregistered medical devices that are connectable to the mobile device may be displayed on the screen. When the user selects a desired medical device from the list for registration, the selected medical device may be added to the medical device list so that it may be registered together with the medical devices A and B.

FIG. **8** is a schematic diagram of a screen of a mobile device that appears when an item 'view examination results' shown in FIG. **6** is selected, according to an exemplary embodiment. An examination result list may be displayed on the screen so that examination results **1** through **8** in the examination result list are arranged in reverse chronological order (most recent examination at the top of the list) or in other ways. An item **801** indicating each of the examination results **1** through **8** may be displayed together with date and time **803** of examination.

FIG. **9** is a schematic diagram of a screen of a mobile device that appears when 'examination result **8**' shown in FIG. **8** is selected, according to an exemplary embodiment. Referring to FIG. **9**, an examination result item **901** may include examination items **903**, examination result values **905**, and normal reference ranges **907**. According to the examination result values **905**, an alarm range indicator **909** and a critical range indicator **911** may be added. In the exemplary embodiment shown in FIG. **9**, the examination items **903** such as Albumin (ALB), Total Protein (TP), Cholesterol (CHOL), Glucose (GLU), Blood Urea Nitrogen (BUN), and High-Density Lipoprotein (HDL) are indicated as having an alarm range value, and the examination item **903** such as BUN is indicated as having a critical range value.

Examination items **903** may include, but not limited to, ALB, Alkaline Phosphatase (ALP), ALT (Alanine Aminotransferase), Amylase (AMY), Aspartate Aminotransferase (AST), BUN, CHOL, Creatine Kinase (CK), Creatinine (CRE), Direct Bilirubin (DBIL), Total Bilirubin (TBIL), GLU, Hemoglobin A1c (HbA1c), HDL, Prostate Specific Antigen (PSA), Troponin I (TnI), and Brain Natriuretic Peptide (BNP). The examination items **903** may also include other various items that can be inspected by a medical device without limitation.

FIGS. **10**A through **10**C are schematic diagrams of screens of a mobile device that appear when the item 'set' **609** shown in FIG. **6** is selected, according to an exemplary embodiment.

FIG. **10**A illustrates a screen for setting an alarm upon selection of the item 'set' **609** shown in FIG. **6**. The alarm may be set to be output upon completion of examination **1001**, upon occurrence of an abnormal condition **1003** (falling out of a preset range), and when a BUN value falls within a critical range **1005**. The alarm for each menu item **1001**, **1003**, or **1005** may be set to be output according to whether a check box next to the item **1001**, **1003**, or **1005** is checked. By selecting a button **1007**, a critical range for a particular examination item may be additionally set.

Upon selection of the button **1007**, a screen of the mobile device shown in FIG. **10**B is displayed. For example, if a critical range for ALT value is set, the type of an acoustic sound or activation of a vibration may be selected, and the critical range for ALT value may be directly determined and entered by a user. When a button **1015** for selecting the type of acoustic sound is pressed, an acoustic sound selection window with a plurality of acoustic sounds listed is displayed in a popup window on the screen, and a desired acoustic sound is selected as an alarm by the user in various ways, e.g. by touching the screen, pressing a button, and moving a cursor. Similarly, when a button **1017** for selecting an examination item whose critical range will be set is pressed, an examination item selection window with a plurality of examination items listed is displayed in a popup window on the screen, and a desired examination item is selected by the user in various ways, e.g. by touching the screen, pressing a button, and moving a cursor. A numeric pad **1019** may also be displayed to allow the user to directly enter a value. When the critical range for ALT value is set by performing the above process, item ALT **1021** may be added to the screen for setting an alarm shown in FIG. **10**A and displayed as shown in FIG. **10**C.

FIG. **11** is a schematic diagram of a screen of a mobile device that displays an alarm status list, according to an exemplary embodiment.

A current alarm status that is read by the mobile device from medical devices (medical devices A and B) may be displayed as an alarm status list shown in FIG. **11**. The current alarm status list may be arranged in reverse chronological order by placing alarm items in order from most recently outputted alarms (i.e., the latest alarm at the top of the list), or in the opposite order. Alarm items may be classified by an icon **1101** indicating completion of examination, an icon **1105** indicating occurrence of an abnormal condition, and an icon **1107** indicating occurrence of an emergency. Each of the alarm items may include identification (ID) information **1103**

about a medical device that has transmitted an alarm, ID information **1109** about an examinee, and date and time **1111** when the alarm isoutput.

The above methods according to the embodiments of the present invention can be recorded as programs that can be executed on a computer and be implemented through general-purpose digital computers which can run the programs using a computer-readable recording medium. Data structures described in the above method can also be recorded on a computer-readable recording medium in a variety of ways. Program storage devices that can be used to describe a storage device containing computer codes executable to perform various methods according to the present invention are not understood to include transitory media such as carrier waves or signals. Examples of the computer-readable recording medium include recording media, such as magnetic storage media (e.g., ROM, floppy disks, hard disks, etc.), and optical recording media (e.g., CD-ROMs or DVDs).

While one or more embodiments of the present invention have been described with reference to the figures, it will be understood by one of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the following claims. Thus, it should be understood that the exemplary embodiments described therein should be considered in a descriptive sense only and not for purposes of limitation. The scope of the invention is defined not by the detailed description of the invention but by the appended claims, and all differences within the scope of the appended claims and their equivalents will be construed as being included in the present invention.

What is claimed is:

1. A method of implementing an alarm for a medical device through a mobile device, the method comprising:

storing examination details of a specimen in the medical device;

establishing a connection with the medical device, the establishing the connection being performed by the mobile device;

reading the examination details stored in the medical device, the reading being performed by the mobile device;

analyzing the read examination details and determining whether a result of the analyzing satisfies a predetermined criterion, the analyzing and the determining being performed by the mobile device; and

outputting an alarm if the result of the analyzing satisfies the predetermined criterion, the outputting being performed by the mobile device.

2. The method of claim **1**, wherein the establishing the connection is repetitively performed for every predetermined period.

3. The method of claim **1**, wherein the connection is maintained only while the mobile device reads the examination details from the medical device.

4. The method of claim **1**, wherein if a result of the analyzing satisfies the predetermined criterion, the result of the examination of the specimen deviates from a preset range, or the examination of the specimen is completed.

5. The method of claim **4**, wherein the preset range is set for an examination item of an individual examinee.

6. The method of claim **5**, wherein when the examination result deviates from the preset range and falls within a critical range, an alarm is output, and an alarm notification is transmitted to a predetermined destination.

7. The method of claim **1**, wherein the medical device recognizes a plurality of mobile devices to record therein a history of the examination details that have been read by the plurality of mobile devices and allows the mobile device to read only examination details that have not been read by the mobile device.

8. The method of claim **1**, wherein the alarm is implemented as at least one from among a bell sound, music, an acoustic sound, a vibration, flashing light, and a popup window.

9. A mobile device for implementing an alarm for a medical device, the mobile device comprising:

a transmitter configured to transmit requests for establishing a connection with the medical device and to read examination details of a specimen stored in the medical device;

a receiver configured to receive from the medical device a response to accept the request for establishing the connection with the medical device and the examination details;

a processor configured to analyze the received examination details and to determine whether a result of analysis of the examination details satisfies a predetermined criterion; and

an alarm unit configured to output an alarm if the result of analysis satisfies the predetermined criterion.

10. The mobile device of claim **9**, wherein the request for establishing the connection with the medical device is repetitively made for every predetermined period.

11. The mobile device of claim **9**, wherein the connection is maintained only while the mobile device establishes the connection with the medical device and receives the examination details from the medical device.

12. The mobile device of claim **9**, wherein if the result of analysis satisfies the predetermined criterion, the result of the examination of the specimen deviates from a preset range, or the examination of the specimen is completed.

13. The mobile device of claim **12**, wherein the preset range is set for an examination item of an individual examinee.

14. The mobile device of claim **13**, wherein when the examination result deviates from the preset range and falls within a critical range, an alarm is output, and an alarm notification is transmitted to a predetermined destination.

15. The mobile device of claim **9**, wherein the mobile device is set to read only examination details that have not been read previously.

16. The mobile device of claim **9**, wherein the alarm is implemented as at least one from among a bell sound, music, an acoustic sound, a vibration, flashing light, and a popup window.

17. A medical device for implementing an alarm through a mobile device, the medical device comprising:

a specimen inserter configured to insert the specimen;

an examination and processing unit configured to examine the specimen and process the result of examination of the specimen;

a storage unit configured to store the examination result;

a receiver configured to receive a request for establishing a connection and reading examination details of the specimen from the mobile device; and

a transmitter configured to transmit a response that accepts the request for establishing the connection together with the examination details,

wherein the medical device records a history of examination details that have been read by the mobile device.

18. The medical device of claim **17**, wherein the request for establishing the connection is repetitively made for every predetermined period.

19. The medical device of claim 17, wherein the connection is maintained only while the mobile device establishes the connection with the medical device and receives the examination details from the medical device.

20. The medical device of claim 17, wherein the transmitter transmits the examination result defined as particular values or ranges of values.

21. The medical device of claim 20, wherein when the examination result deviates from a preset range and falls within a critical range, the transmitter transmits an alarm notification to a predetermined destination.

22. The medical device of claim 17, wherein the medical device recognizes a plurality of mobile devices to record therein a history of the examination details that have been read by the plurality of mobile devices and allows the mobile device to read only examination details that have not been read by the mobile device.

23. The medical device of claim 17, wherein the mobile device analyzes the received examination details and outputs an alarm if the result of analysis of the examination details satisfies a predetermined criterion.

24. The medical device of claim 17, wherein the alarm is implemented as at least one from among a bell sound, music, an acoustic sound, a vibration, flashing light, and a popup window.

25. A non-transitory computer-readable recording medium having recorded thereon a program for executing the method of claim 1 on a computer.

26. A method of implementing an alarm for a medical device through a mobile device, the method comprising:

storing information about a current status of the medical device in the medical device;

establishing a direct connection with the medical device via wired or wireless communication networks, the establishing of the direct connection being performed by the mobile device;

reading the information about the current status of the medical device stored in the medical device, the reading being performed by the mobile device; and

displaying the information read by the mobile device on a screen.

27. The method of claim 26, wherein the current status is at least one from among a standby status, an off status, a disconnected status, and an examination in-progress status.

28. The method of claim 27, wherein the examination in-progress status is represented by displaying a rate of examination progress on the screen by a percentage value or a graphical representation.

29. A mobile device for implementing an alarm for a medical device, the mobile device comprising:

a transmitter configured transmit a request for establishing a direct connection with the medical device via wired or wireless communication networks, and reading information about a current status of the medical device, stored in the medical device;

a receiver configured to receive from the medical device a response to accept the request for establishing the direct connection with the medical device and the information about the current status of the medical device; and

a display configured to display the received information about the current status of the medical device.

30. The mobile device of claim 29, wherein the current status is at least one from among a standby status, an off status, a disconnected status, and an examination in-progress status.

31. The mobile device of claim 30, wherein an examination in-progress status is represented by displaying a rate of examination progress on the screen by a percentage value or a graphical representation.

32. The medical device of claim 17, wherein the medical device transmits the examination details that have not been read by the mobile device based on the history of examination details.

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